WHAT IS CLAIMED IS:

1. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that:

calculates an exhaust gas air-fuel ratio of a cylinder when valve opening characteristics of an intake valve and an exhaust valve of each of the cylinders of the internal combustion engine are set such that an amount of an intake air introduced into the cylinder is not limited by the valve opening characteristics; and

reduces a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

2. A control apparatus according to claim 1, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the valve opening characteristics of the intake valve and the exhaust valve of each cylinder are set such that the amount of the intake air introduced into each cylinder of the internal combustion engine is limited by a throttle valve opening amount.

3. A control apparatus according to claims 1, wherein the controller:

calculates the exhaust gas air-fuel ratio of the cylinder when the valve opening characteristics of the intake valve and the exhaust valve are set such that the amount of the intake air introduced into the cylinder is limited by the valve opening characteristics after reducing the variation in the fuel injection quantity among the plurality of cylinders; and

reduces a variation in the valve opening characteristics of the intake valve and the exhaust valve among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of the cylinder.

4. A control apparatus according to claim 3, wherein the controller calculates the exhaust gas air-fuel ratio of the cylinder when the valve opening characteristics of the intake valve and the exhaust valve are set such that the amount of the intake air introduced into the cylinder is not limited by a throttle valve opening amount, but is limited by the valve opening characteristics of the intake valve and the exhaust valve after reducing the variation in the fuel injection quantity among the plurality of cylinders.

5. A control apparatus according to claim 1, wherein a neural network is used to reduce the variation among the plurality of cylinders.

6. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that:

calculates an exhaust gas air-fuel ratio of each of the cylinders when an operation angle of an intake valve of each cylinder of the internal combustion engine is set to a predetermined angle; and

reduces a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

7. A control apparatus according to claim 6, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the operation angle of the intake valve is set such that an amount of intake air introduced into a cylinder of the internal combustion engine is not limited by the operation angle of the intake valve.

8. A control apparatus according to claim 7, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the amount of the intake air introduced into each cylinder of the internal combustion engine is not limited by the operation angle of the intake valve, but is limited by a throttle valve opening amount.

9. A control apparatus according to claim 6, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the operation angle of the intake valve is set to a maximum operation angle.

10. A control apparatus according to claims 6, wherein the controller:

calculates the exhaust gas air-fuel ratio of each of the cylinders when valve opening characteristics of the intake valve and an exhaust valve are set such that an amount of intake air introduced into each of the cylinders is limited by the valve opening characteristics after reducing the variation in the fuel injection quantity among the plurality of cylinders; and

reduces a variation in the valve opening characteristics of the intake valve and the exhaust valve among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

11. A control apparatus according to claim 6, wherein the controller:

calculates the exhaust gas air-fuel ratio of each of the cylinders when the operation angle of the intake valve is set to an operation angle that is smaller than the predetermined angle after reducing the variation in the fuel injection quantity among the plurality of cylinders; and

reduces a variation in the amount of the intake air among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

12. A control apparatus according to claim 6, wherein the controller:

calculates the exhaust gas air-fuel ratio of each of the cylinders when the operation angle of the intake valve is set to an operation angle that is smaller than the predetermined angle after reducing the variation in the fuel injection quantity among the plurality of cylinders; and

reduces a variation in the operation angle of the intake valve among the cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

13. A control apparatus for a multi-cylinder internal combustion engine, the control apparatus comprising a controller that:

calculates an exhaust gas air-fuel ratio of each of the cylinders when a valve overlap amount of an intake valve and an exhaust valve of each of the cylinders of the internal combustion engine is set to a predetermined amount; and

reduces a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

14. A control apparatus according to claim 13, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the valve overlap amount of the intake valve and the exhaust valve is set such that an amount of the intake air introduced into each of the cylinders is not limited by the valve overlap amount.

15. A control apparatus according to claim 14, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the valve overlap amount of the intake valve and the exhaust valve is set such that the amount of the intake air introduced into each of the cylinders is not limited by the valve overlap amount, but is limited by a throttle valve opening amount.

16. A control apparatus according to claim 13, wherein the controller calculates the exhaust gas air-fuel ratio of each of the cylinders when the valve overlap amount of the intake valve and the exhaust valve is set to a minimum amount.

17. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that reduces a variation among the plurality of cylinders on the basis of a valve overlap amount of an intake valve and an exhaust valve of each of the cylinders.

18. A control apparatus according to claim 17, wherein the controller reduces a variation in a fuel injection quantity among the plurality of cylinders on the basis of the valve overlap amount of the intake valve and the exhaust valve of each of the cylinders.

19. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that reduces a

variation among the plurality of cylinders on the basis of an operation angle of an intake valve of each of the cylinders.

20. A control apparatus according to claim 19, wherein the controller reduces a variation in an air-fuel ratio among the plurality of cylinders on the basis of the operation angle of the intake valve of each of the cylinders.

21. A control apparatus according to claim 20, wherein the controller reduces a variation in the air-fuel ratio among the plurality of cylinders by correcting a fuel injection quantity on the basis of the operation angle of the intake valve.

22. A control apparatus according to claim 21, wherein an amount of correction of the fuel injection quantity is increased as the operation angle of the intake valve is decreased.

23. A control apparatus according to claim 21, wherein the controller:

calculates a fuel injection quantity correction coefficient for reducing the variation in the air-fuel ratio when the variation in the air-fuel ratio among the cylinders is detected;

calculates a relationship between the calculated fuel injection quantity correction coefficient and the operation angle of the intake valve obtained upon calculation of the fuel injection quantity correction coefficient; and

updates the fuel injection quantity correction coefficient when the operation angle of the intake valve is changed on the basis of the changed operation angle and the calculated relationship.

24. A control apparatus according to claim 23, wherein the fuel injection quantity correction coefficient changes relative to the operation angle of the intake valve such that an amount of correction of the fuel injection quantity is increased as the operation angle is decreased.

25. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that corrects a coefficient for an air-fuel ratio feedback control to a predetermined coefficient on the basis of an operation angle of an intake valve of each of the cylinders wherein a number of sensors provided in the internal combustion engine for detecting an air-fuel ratio or an oxygen concentration is smaller than a number of the cylinders of the internal combustion engine.

26. A control apparatus according to claim 25, wherein the coefficient for the air-fuel ratio feedback control is corrected to the predetermined coefficient such that a target air-fuel ratio is increased as the operation angle of the intake valve is decreased.

27. A control apparatus according to claim 25, wherein the controller:

calculates a target air-fuel ratio when a variation in the air-fuel ratio among the plurality of cylinders is detected;

calculates a relationship between the target air-fuel ratio and the operation angle of the intake valve on the basis of the calculated target air-fuel ratio and the operation angle of the intake valve obtained upon detection of the variation in the air-fuel ratio; and

updates the target air-fuel ratio when the operation angle of the intake valve is changed on the basis of the changed operation angle of the intake valve and the calculated relationship between the target air-fuel ratio and the operation angle of the intake valve of the cylinder.

28. A control apparatus according to claim 25, wherein the controller:

reduces a variation in the air-fuel ratio among the cylinders by correcting a fuel injection quantity of each of the cylinders independently when an amount of correction of the calculated fuel injection quantity is smaller than a predetermined value; and

guards the amount for correcting the calculated fuel injection quantity, corrects the target air-fuel ratio, and uniformly corrects the fuel injection quantity of all the cylinders on the basis of the corrected target air-fuel ratio when an amount of correction of the calculated fuel injection quantity is larger than the predetermined value.

29. A control apparatus for a multi-cylinder internal combustion engine including a plurality of cylinders, the control apparatus comprising a controller that corrects a target air-fuel ratio on the basis of an operation angle of an intake valve of each of the cylinders wherein a number of sensors provided in the internal combustion engine for detecting an air-fuel ratio or an oxygen concentration is smaller than a number of the cylinders of the internal combustion engine.

30. A control apparatus according to claim 29, wherein the target air-fuel ratio is corrected such that an amount for correcting the target air-fuel ratio is increased as the operation angle of the intake valve is decreased.

31. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising the steps of:

calculating an exhaust gas air-fuel ratio of a cylinder when valve opening characteristics of an intake valve and an exhaust valve of each of the cylinders of the internal combustion engine are set such that an amount of an intake air introduced into the cylinder is not limited by the valve opening characteristics; and

reducing a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

32. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising the steps of:

calculating an exhaust gas air-fuel ratio of each of the cylinders when an operation angle of an intake valve of each of the cylinders of the internal combustion engine is set to a predetermined angle; and

reducing a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

33. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising the steps of:

calculating an exhaust gas air-fuel ratio of each of the cylinders when a valve overlap amount of an intake valve and an exhaust valve of each of the cylinders of the internal combustion engine is set to a predetermined amount; and

reducing a variation in a fuel injection quantity among the plurality of cylinders on the basis of the calculated exhaust gas air-fuel ratio of each of the cylinders.

34. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising reducing a variation among the plurality of cylinders on the basis of a valve overlap amount of an intake valve and an exhaust valve of each of the plurality of cylinders.

35. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising reducing a variation among the plurality of cylinders on the basis of an operation angle of an intake valve of each of the plurality of cylinders.

36. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising correcting a coefficient for an air-fuel ratio feedback control to a predetermined coefficient on the basis of an operation angle of an intake valve of each of the cylinders, in which a number of sensors provided in the internal combustion engine for detecting an air-fuel ratio or an oxygen concentration is smaller than a number of the cylinders of the internal combustion engine.

37. A method of controlling a multi-cylinder internal combustion engine including a plurality of cylinders, comprising correcting a target air-fuel ratio on the basis of an operation angle of an intake valve of each of the cylinders, in which a number of sensors provided in the internal combustion engine for detecting an air-fuel ratio or an oxygen

concentration is smaller than a number of each of the cylinders of the internal combustion engine.